

#61-F-53

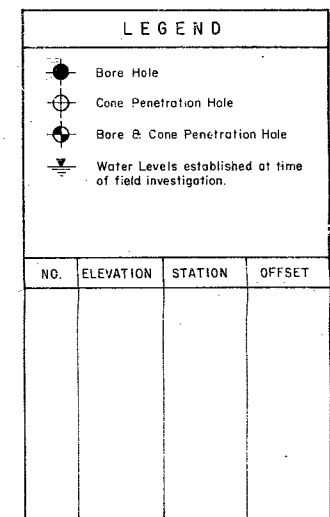
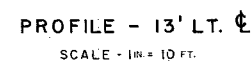
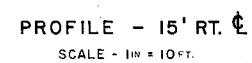
W.P.# 213-60

Hwy. #21

SPECIAL DESIGN

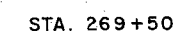
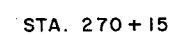
CULVERT

N. OF GODERICH



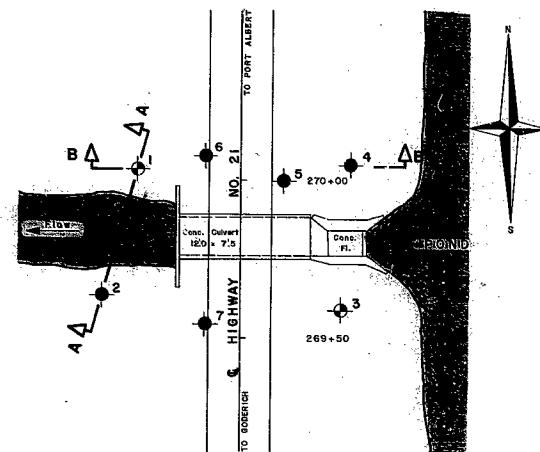
- NOTE -

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

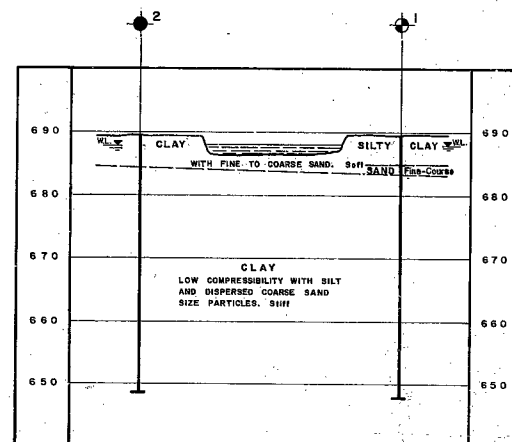
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REVISIONS			
	DATE	BY	DESCRIPTION

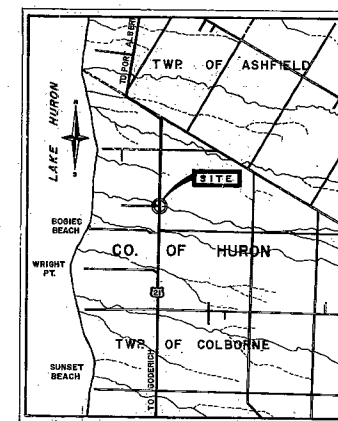
<b>DEPARTMENT OF HIGHWAYS - ONTARIO</b> <b>MATERIALS &amp; RESEARCH DIVISION - FOUNDATION SECTION</b>			
<h2 style="margin: 0;">CULVERT INVESTIGATION</h2> <p style="margin: 5px 0 0 0;">(NORTH OF GODERICH)</p>			
KING'S HIGHWAY NO. <u>21</u>		DIST. NO. <u>3</u>	
CO. <u>HURON</u>		LOT <u>6</u>	
TWP. <u>COLBOURNE</u>		CON. _____	
<b>SUB - SOIL STRATIGRAPHY</b>			
SUBMIT:	CHECKED	W.R. NO. <u>213-60</u>	M & R. DRAWING NO.
DRAWN F.C.	CHECKED <u>...</u>	JOB NO. <u>61-F-53</u>	<b>61-F-53B</b>
DATE <u>NOV. 6, 1963</u>		SITE NO.	BRIDGE DRAWING NO.
APPROVED <u>[Signature]</u>		CONT. NO.	



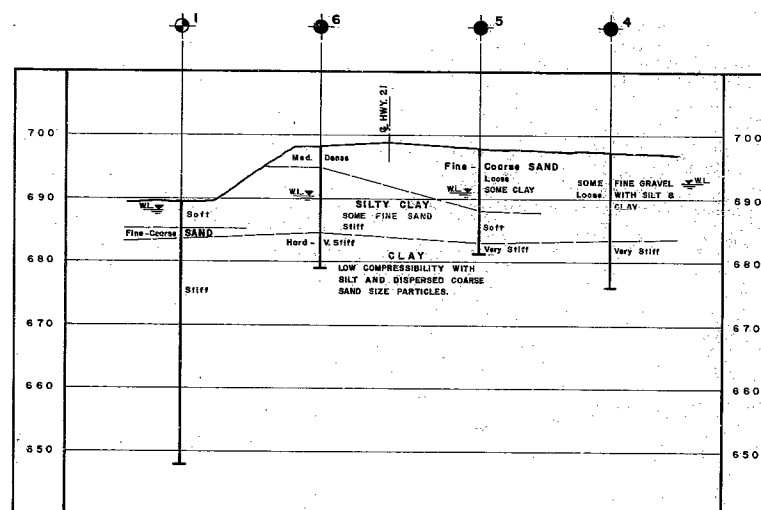
**PLAN**  
SCALE: 1 inch = 20 feet



**A - A**  
SCALE: Vert. 1 inch = 10 feet  
Horiz. 1 inch = 10 feet



**KEY PLAN**  
SCALE: 1 inch = 1 mile



**B - B**  
SCALE: Vert. 1 inch = 10 feet  
Horiz. 1 inch = 10 feet

LEGEND			
BORE & PENETRATION HOLE			
BORE HOLE			
HOLE	ELEVATION	STATION	OFFSET
1	689.5	270+04	33' LT.
2	689.5	269+64	44' LT.
3	697.0	269+59	32' RT.
4	697.5	270+05	35' RT.
5	698.0	270+00	14' RT.
6	698.5	270+08	11' LT.
7	698.5	269+55	11' LT.

DEPARTMENT OF HIGHWAYS - ONTARIO			
MATERIALS & RESEARCH SECTION			
SPECIAL DESIGN CULVERT			
ON			
HIGHWAY NO. 21			
STATION 269+82			
40P13-5			
ORIGINATED: E. WIDDIS	DISTRICT: 3	DATE: 12 JULY 1981	GEODESIC No.
DRAWN: D. HUMFORD	W.P. NO. 213-80	JOB NO. 61-F-55	
CHECKED: [Signature]	SCALE	DRAWING NO.	
APPROVED: [Signature]	AS SHOWN	61-F-53A	

Mr. A. Gater,  
Sr. Project Design Engineer,  
London Regional Office.

H. D. McMillan,  
Road Design Division,  
Downsview, Ont.

December 17, 1963.

Work Project 213-60 - Highway #21 North of Goderich  
Construction of Dam

1. In reply to memorandum, dated November 18, 1963 from Mr. R. Jenkins recommending that the resolution of the Council of the Township of Colborne requesting the dam elevation be raised an additional 20 ft., that is, a total raise of 4.0 ft. above the present level of the dam.
2. We concur with Mr. R. Jenkins' recommendation, there, please revise the drawings, estimates, etc. as soon as possible. Please ensure that the Soils recommendations for the fill treatments are clearly shown on design plans.

HDM:gc.  
c.c. W. Wible  
W. McFarlane  
A. Stermac  
E. Cross

H. D. McMILLAN,  
ROAD DESIGN ENGINEER.

Mr. J. Roy,  
Regional Materials Engr.,  
London Regional Office.

Attn: Mr. J. Forster

Mr. A. G. Stermac,  
Principal Foundation Engr.,  
Foundation Section,  
Materials & Research Division.  
November 6, 1963

W.P. 213-60 - W.J. 61-F-53  
Hwy. #21, Goderich Northerly,  
District #3

In our memo of August 6, 1963, to Mr. S. McCombie, Bridge Planning Engineer, we commented on the various proposed dam elevations. In conclusion, we pointed out that very little information on the embankment and the underlying soil was available, and therefore, more conclusive comments and recommendations were not possible. We also pointed out the fact that the existing embankment was not originally built as a water retaining structure and that therefore, the materials used may not be best suited for the presently proposed purpose.

We are now in receipt of the results of additional borings carried out by the Regional Material Engineer's personnel. These results are summarized on the attached drawing (61-F-53B) on which two cross- and two longitudinal sections are shown. The soil stratification is drawn on these sections.

It is evident from this drawing that a number of different materials were used for the embankment construction and also, that in places, the soft organic topsoil was not removed prior to embankment construction. Some of the embankment materials are rather permeable due to their sandy character. It appears that these materials are presently above the prevailing pond water table.

On the basis of the results of the most recent investigation, it can now be concluded that it would be advisable to have the pond level raised as little as possible.

If the desired dam level raise of 4.0 ft. is carried out, the water during flood, may be anticipated to rise to elev. 700.00. With a 3.6 ft. high freeboard, the embankment would have to be raised up to elev. 703.60 which is about 5 to 5.5 ft. above the present elevation. We are unable to state specifically that a failure will occur in this case; however, in the light of the available data we can say that difficulties are very probable.

AGS/MdeF

Attach.

cc: Messrs. S. McCombie  
W. McFarlane

Foundations office  
Gen. Files

*A. G. Stermac*  
A. G. Stermac  
PRINCIPAL FOUNDATION ENGINEER

Mr. J. Roy,  
Regional Materials Engr.,  
London Regional Office.

Attn: Mr. J. Forster

Mr. A. G. Sternac,  
Principal Foundation Engr.,  
Foundation Section,  
Materials & Research Division.

November 6, 1961

W.P. 213-60 - W.J. 61-F-53  
Hwy. #21, Goderich Northerly,  
District #1

In our memo of August 6, 1961, to Mr. S. McCombie, Bridge Planning Engineer, we commented on the various proposed dam elevations. In conclusion, we pointed out that very little information on the embankment and the underlying soil was available, and therefore, more conclusive comments and recommendations were not possible. We also pointed out the fact that the existing embankment was not originally built as a water retaining structure and that therefore, the materials used may not be best suited for the presently proposed purpose.

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It is evident from this drawing that a number of different materials were used for the embankment construction and also, that in places, the soft organic top soil was not removed prior to embankment construction. Some of the embankment materials are rather permeable due to their sandy character. It appears that these materials are presently above the prevailing pond water table.

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AGS/MdeF

Attach.

cc: Messrs. S. McCombie  
W. McFarlane

Foundations Office  
Gen. Files

*A. G. Sternac*  
A. G. Sternac  
PRINCIPAL FOUNDATION ENGINEER

DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT



ONTARIO

DEPARTMENT OF HIGHWAYS

Memo to Mr. T. Stermac Date October 17, 1963  
Downsview  
Principal Foundations Engineer- Subject Re: W.P. 213-60, Highway 21,  
Materials & Research-London Goderich Northerly, Dam Site at  
Station 270/- (Job 61-F-53).

Additional borings have been carried out at this site and the soils data along with a soils profile has been included with this memo for your information.

The upper 9 to 12 feet of the road embankment consists of a heterogeneous mixture of sand and clay layers with sandy clay loam and topsoil encountered in places. These materials were soft and saturated from about 5 feet to 12 feet below the pavement level in most of the holes on the right side of the road. This moisture condition is not as severe on the left side of the road although there is a layer (about 2 feet in depth) of saturated clay with sand seams approximately 12 feet below the pavement elevation.

The parent material is a light to medium clay of stiff consistency with the following Atterburg Limits:

L.L.	-	26.1%	:	varies from	22.9	to	28.6
P.L.	-	13.5%	:	"	"	12.9	" 14.4
P.I.	-	12.6%	:	"	"	9.5	" 15.3
M.C.	-	15.2%	:	"	"	12.8	" 17.6

I hope this information will be of some use to you.

JF/je  
cc: J. McKeown  
file

for:

*J. Forster*  
J. Forster  
J.R. Roy  
Regional Materials Engineer

Mr. John Forster,  
Regional Office,  
London, Ontario.

Mr. A. G. Stermac, ac,  
Foundation Division,  
Materials Research Div.

September 18, 1963

W.P. 213-60,  
Combined Culvert and Dam,  
Hwy. #21, Sta. 269+82,  
District #3.

Attached, I am sending you a copy of our memo to Mr. Gavin Scott and a copy of his memo to Mr. L. D. Barrett, concerning the raising of the pond level. I remember Gavin telling me that the whole problem is far more complicated than can be seen from the available correspondence. However, I had the feeling that the problem was resolved. The fact that you are now asking for some additional comments, makes me aware that maybe all was not settled after all. I would, therefore, strongly advise that you check on the history and present state with Gavin Scott, before you make any further commitments.

ACS/MdeF

*A. G. Stermac*  
A. G. Stermac,  
PRINCIPAL FOUNDATION ENGINEER

cc: Foundations Office



Copy for the information of

Mr. A. Stermac,  
Principal Foundation Engineer,  
Room 107, Lab. Bldg.

Mr. L. D. Barrett,  
District Engineer,  
STRAITFORD, Ontario.

Attention: Mr. W. Westlake

Gavin Scott

August 20, 1963.

W.P. 213-60  
Combined Culvert and Dam  
Hwy. #21 Sta. 269 + 82  
District #3

We have reviewed the above project in co-operation with the Hydrology, Foundations and Culvert Design Sections and in reply to your letter of July 23rd would submit the following notes to assist in arriving at a proper decision concerning the proposed dam.

1. Hydrologically there is no objection to the proposed increase in height of the dam.
2. Insofar as probable overtopping is concerned the presently proposed embankment elevation would permit the dam to be raised to elevation 696.6 (this corresponds to the recent request by Mr. Hill).
3. If the design high water level is to exceed elevation <sup>700.0</sup>~~695.0~~ a corresponding increase in the roadway elevation would be required.
4. The quality of the present embankment cannot properly be determined at this time, however it may be that some reasonable risk of damage to the embankment could be taken. In that case it is considered that periodic supervision of the embankment would be advisable until experience showed that the embankment was stable.
5. Weak portions of the embankment could be repaired as they became evident.
6. The increase in the cost of the revised culvert and dam structure would be relatively small amounting to \$300.00.
7. The cost of possible repairs to the embankment ----- not estimated.

We will be pleased to know what is the ultimate decision and hope that you will find these notes of assistance.

GS/es  
cc. E. McCombie  
cc. A. Gater  
cc. A. Stermac  
cc. J. D. Harris  
cc. W. McFarlane

Gavin Scott,  
Bridge Location Engineer.

MEMORANDUM

To: Mr. A. Stermac,  
Principal Foundations Engineer,  
Lab. Bldg.

FROM: W. McFarlane

Attn.: Mr. K. Y. Lo

DATE: August 7, 1963.

OUR FILE REF.

IN REPLY TO

SUBJECT: W.P. 213-60,  
Combined Culvert and Dam,  
Hwy. 21, Sta. 269 + 82,  
District #3

The elevation of the top of the existing dam is approximately 692.50.

The elevation of the top of the dam, as presently shown on drawing D 4987-1 is 694.60. At the design flood the head required to discharge the flow over the weir is approximately 3.4 feet. This results in a head water elevation of 698.0, as recommended in the soils report 61-F-53, dated July, 1961.

With the present available information you have, you informed me today that it would be permissible to raise the head water elevation 2 feet to elevation 700.00; this would result in an elevation of 696.6 for the dam. No additional soils information would be required and the design section of the embankment would not have to be altered, however, the design for the culvert would have to be modified.

If the head water level is raised to 702.00, i.e. a resultant elevation of 698.6 for the dam, additional soils information would be required and the design cross section of the embankment would have to be altered. The grade would have to be raised and gravel filters would have to be employed on the downstream toe of the embankment.

WMcF/ah



W. McFarlane,  
Sr. Design Services Engineer.

c.c. H. McMillan

Mr. S. McCombie,  
Bridge Planning Engr.,  
Bridge Division.

Mr. A. G. Stermac,  
Principal Foundation Engr.,  
Foundation Section,  
Materials & Research Division.

Attn: Mr. G. Scott,  
Bridge Location Engr.

August 6, 1963

W.P. 213-60,  
Combined Culvert and Dam,  
Hwy. #21, Station 269+82,  
District #3.

In response to the request regarding necessary measures in connection with a possible increase of the high water level, contained in your memo of July 29, 1963, we have reviewed the recommendations made in our report of July 18, 1961 (W.J. 61-F-53), and have also discussed the entire proposed scheme with you on August 1, 1963.

We understand that the present dam level is at elev. 692.60. A proposed increase of 2 ft. is shown on the Preliminary Plan D-4987-P, dated November 1961. Presently, two additional alternatives involving further increases of 2 and 4 feet, respectively, are under consideration. We also understand that it is safe to assume that the flood water level will never be higher than 3.4 ft. above the dam level.

On the above-mentioned Preliminary Plan, the dam level is shown as 694.60; therefore, the flood water level could reach elev. 698.00. The road elevation is shown as 703.60, thus creating a freeboard of 5.6 ft.

After reconsidering the dimensions and depth of the retained water, we came to the conclusion that such a freeboard is rather conservative, and it could therefore, be reduced to 3.6 ft. which would allow for an additional increase of 2 ft. of the dam. If, instead of an increase of 2 ft., 4 ft. would be required, we would recommend that the road embankment be raised to elev. 705.6.

However, we would like to draw to your attention, the fact that the previously mentioned requirements satisfy only one condition, and that is the prevention of the water overtopping the road embankment. It should be kept in mind that the road embankment was not built as a water retaining structure and that the knowledge of the subsoil underlying the road is practically non-existent. Only a very limited investigation was carried out at the culvert site and this has revealed everything but favourable conditions. As the height of the impounded water is increased,

cont'd. /2 ...

Mr. S. McCombie,  
Attn: Mr. G. Scott.

- 2 -

August 6, 1963

higher pressures and higher gradients are created, and it is presently not known whether and when any of them could become critical. But it has to be acknowledged that the conditions are becoming more critical as the level of water in the pond is being increased. We would, therefore, suggest that when the final decision is being reached, the above-mentioned is kept in mind.

AGS/MdeF

  
A. G. Stermac  
PRINCIPAL FOUNDATION ENGINEER

cc: Foundations Office  
Gen. Files

MEMORANDUM

To: Mr. A. Stermac,  
Principal Foundations Engineer,  
Lab. Bldg.

FROM: G. Scott

ATTENTION: Mr. K. Y. Lo

DATE: July 29, 1963.

OUR FILE REF.

IN REPLY TO

SUBJECT: W.P. 213-60  
Combined Culvert and Dam  
Hwy. 21 Station 269 + 82  
District #3.

Attached hereto please find a copy of a letter from Mr. Barrett dated July 23rd, 1962 and also the pertinent Colborne Township resolution.

In your report BA 1230 the water level in the pond is controlled by the elevation of the proposed roadway.

We would be pleased to have your requirements in the event the high water level was raised to

- (a) Elevation 700'
- (b) " 702'.

GS:ew  
c.c. S. McCombie  
L. D. Barrett  
A. Gater.

  
G. Scott,  
Bridge Location Engineer.

## MEMORANDUM

To: Mr. S. McCombie,  
Bridge Planning Engineer.

From: District #3, Stratford.

Attn: Mr. Gavin Scott,  
Bridge Location Engr.

Date: July 23rd, 1963.

Our File Ref.

IN REPLY TO

## SUBJECT:

W. P. No. 213-60,  
Goderich Northerly,  
Highway No. 21,  
Combined Culvert & Dam.

Mr. Hugh Hill has called at the District Office several times to discuss further, the possibility of having the dam raised an additional two feet.

We have explained to Mr. Hill that by raising the elevation of the water, this could affect our fill slope and possibly saturate the roadbed. However, Mr. Hill is quite pleased with the raise as shown on our Plan D-4987-1 but, feels it would be advantageous to all concerned to have a larger storage basin.

*plus*  
We attach hereto a copy of a resolution forwarded to this office by the Township of Colborne. Apparently the Township Council are of the opinion that a larger water storage area would be desirable.

We would appreciate your comments in this regard.

*L. D. Barrett*  
L. D. Barrett,  
District Engineer.

WW/bh

Encl.

# Township of Colborne

## CLERK'S OFFICE

R.R. No. 4

Goderich - Ontario

JUL 20 1963

July 20, 1963

Mr. L. D. Barrett, District Engineer,  
Ont. Dept. of Hwys.,  
Box # 3,  
Stratford, Ont.

Dear Sir:

Re: Hwy # 21 Reconstruction Programmes  
Hill Bros. Dam--Lot 12 LRE Conc. Twp. Colborne

The under-noted resolution, in support of a representation made to Colborne Council by Hill Brothers, was approved by the Township of Colborne Council on Monday, July 15, 1963.

Your favourable consideration of same would be appreciated by Council.

Yours very truly,

TOWNSHIP OF COLBORNE

BCS/

cc--Mr. Hugh Hill-Goderich.

Clerk-Treas

" Moved by Councillor Hardy, seconded by Councillor Clark, and carried:

Whereas certain Highway reconstruction work will be undertaken at the site of the Hill Brothers Dam along Lot 12, LRE, Twp. of Colborne:

And Whereas it has been pointed out to Council that raising the level of the existing dam would result in more water storage which would be a definite asset to the municipality:

And Whereas Council is of the opinion that such storage of water would be desirable:

Be it therefore resolved that Council endorse this representation and forward recommendation to the appropriate Highway Authority for their consideration in reconstructing this dam to the maximum height possible consistent with the safety factors involved, with a suggestion that the proposed increase in the height of the present dam be increased by at least four feet."

OFFICE LOCATION -  
DOWNSVIEW AVE.,  
KEELE ST. - HIGHWAY 401  
TORONTO, ONTARIO.



ONTARIO  
DEPARTMENT OF HIGHWAYS

POSTAL ADDRESS -  
DEPARTMENT OF HIGHWAYS  
PARLIAMENT BUILDINGS,  
TORONTO 5, ONTARIO.

Bridge Division,  
June 6, 1961.

MEMORANDUM TO:

Mr. N. D. Smith,  
Soils & Materials  
Planning Supervisor,  
Department of Highways,  
Materials & Research Branch,  
Downsview, Ontario.

61-F-53

RE: W.P. 213-60  
Special Design Culvert  
@ Sta. 269+82, Highway #21  
North of Goderich  
District #3 Stratford

We are planning the replacement of the above culvert and adjacent dam with a combined culvert and dam at the same site.

The attached sketch indicates our preliminary proposals and reflects the property owners request that we should raise the level of the weir as much as possible.

The pond provides storage for Forest Fire Fighting water and also provides means for dissipating the energy of the stream in flood.

A box culvert with 15' span has been recommended by the hydrology section and it will be possible by increasing the length of the weir to regulate to some extent the flood elevation.

We will be pleased if you will arrange to have the site investigated and inform us.

1. The height to which the weir can be raised (As indicated above we anticipate no difficulty in controlling the flood elevation).

.....2



RE: W.P. 213-60

2. The length of culvert at the downstream end which you would recommend for backfill with granular material in order to filter any possible leakage. We assume that a low permeable material will be used for backfill to the balance of the culvert.

The Existing weir elevation is  
The Estimated high water level  
with existing conditions

1692.6

1697.0

44

*Gavin Scott*

GS/bm

Gavin Scott,  
Bridge Location Engineer.

c.c. S. McCombie  
A. Gater

Mr. A. H. Toye,  
Bridge Engineer.  
Materials & Research Section,  
(Foundations Office).

July 13, 1961.

D.M.C. FOUNDATION INVESTIGATION  
REPORT.  
M.J. 61-7-53 -- W.P. 213-66.

Attention: Mr. A. McCosbie.

Re: Special Design Culvert  
at Sta. 269+82, Hwy. #21 N. of Goderich,  
District #3, Stratford, Ontario.

We are forwarding to you, our detailed foundation  
report on the subsoil conditions existing at the above location.

We trust you will find the conclusions and recom-  
mendations summarized in this report, satisfactory for your future  
design work.

Should there be any queries in connection with this  
project that you would like to discuss, please do not hesitate  
to contact our Office.

AGS/4167

Attach.

cc: Messrs. A. H. Toye (2)  
H. A. Tragnakes  
H. D. McMillan  
A. Gater  
L. D. Barrett  
J. Hoy  
T. J. Kovich  
J. E. Grunpier  
E. E. Saint  
F. Norman  
A. Watt  
Foundations Office ✓  
Gen. File.

D. C. Stierman,  
PRINCIPAL FOUNDATION ENGR.

Per:

*A. C. Stierman*  
(A. C. Stierman,  
SUPERVISING FOUNDATION ENGR.)

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1. INTRODUCTION.
  2. DESCRIPTION OF SITE AND GEOLOGY.
  3. FIELD AND LABORATORY INVESTIGATION.
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    - 4.2) Fine to Medium Sand with Gravel, Silt and Clay.
    - 4.3) Clay with some Fine to Coarse Sand and Organic Matter.
    - 4.4) Silty Clay with Dispersed Coarse Sand.
  5. GROUND WATER CONDITIONS.
  6. DISCUSSION AND RECOMMENDATIONS.
  7. SUMMARY.
  8. MISCELLANEOUS.
-

# FOUNDATION INVESTIGATION

For

## SPECIAL DESIGN CULVERT

At Station 269+82, Hwy. #21, North of Goderich  
District #3, Stratford, Ontario  
W.P. 213-60 -- W.J. 61-F-53.

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### 1. INTRODUCTION:

A soils investigation was carried out to determine the subsoil conditions at a culvert located approx. 7 miles north of Goderich on Hwy. #21. This culvert is to be replaced by a combined culvert and dam with which it is intended to control the water level in a pond, which is at present, contained by the existing road embankment. The grade of the road is to be raised by approx. five feet and it has been requested that the level of the water in the pond be raised to a maximum safe elevation. The existing culvert having a 12.0' span is to be replaced by one having a 15.0' span.

### 2. DESCRIPTION OF THE SITE AND GEOLOGY:

The culvert lies in the Huron Slope Clay Plain. The soil at the surface is a brown silty clay containing coarse sand and fine gravel. An embankment built across the culvert, dams a small pond some 130.0' wide which provides a source of water for fire fighting and dissipates the energy of the flood water. The water level in this pond is controlled by a small concrete dam built some 20.0' to the east of the culvert. At the time of the investigation, the outflow was negligible. The water from the pond flows sluggishly into Lake Huron, one mile to the west.

cont'd. /2 ...

### 3. FIELD AND LABORATORY INVESTIGATION:

The field work consisted of two dynamic cone penetration tests and seven boraholes taken down to various elevations. A standard split spoon sampler was used to obtain disturbed samples and 'N' values in the very stiff to stiff clay and the cohesionless materials. Undisturbed samples were obtained in the soft clay by using 2.0" I.D. Shelby tubes. All the samples were visually identified in the field and taken to the laboratory where routine index property tests and shear strength tests were carried out, the results of which are contained in the log sheets of this report. Particle size distribution curves for representative samples are also contained in this report.

### 4. SUBSOIL CONDITIONS:

#### 4.1) General:

The existing road and former railway embankment approximately 9.0' high, consists of a heterogeneous mixture of sand, silt and clay. Particle size distribution curves for samples of this material are found in the Appendix of this report. Beneath the embankments is the naturally deposited grey clay.

#### 4.2) Embankment Fill Material. - Fine to Medium Sand with Gravel Silt and Clay:

In B.H. 's 3 and 4, the fill material consisted of loose, fine to medium sand for its entire depth, and an 'N' value of 4 has been chosen as representative for this material.

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.2) (cont'd.) ...

In B.H.'s 5, 6 and 7, the fine to medium sand is found varying in depth from 5.0' in B.H. 6 to 10.0' in B.H.'s 5 and 7. Underlying it is a brown silty clay varying in thickness from 4.0' in B.H.'s 5 and 7 to 9.0' in B.H. 6. An undrained triaxial test on a sample of this material gave a shear strength value of 1400 lbs./ft.<sup>2</sup>. Beneath this brown clay is the naturally deposited very stiff grey clay.

4.3) Clay with some Fine to Coarse Sand and Organic Matter:

This soft clay, containing fine to coarse sand and organic matter, is found in B.H.'s 1 and 2 and extends to a depth of 5.0'. Atterberg limits are: L.L. 44.3%, P.L. 19.4%, and the Moisture Content 28.4%. Laboratory vane and undrained triaxial shear strength tests indicated a shear strength of the order of 300 lbs./ft.<sup>2</sup>.

4.4) Silty Clay with Dispersed Coarse Sand:

This silty clay with dispersed coarse sand underlies the site and was proved from an elevation of 683.5' to a depth of 40.0'. The 'N' values fall gradually from 42 at an elevation of 683.5' to 15 at 654.5'. However, at an elevation of 649.5' the 'N' value is 43 and it is thought that this clay may have been laid down in two stages and subjected to separate consolidating forces.

Average Atterberg limits are: L.L. 22.2%, P.L. 13.2%, and w/c 16.2%. Its density is of the order of 133.0 lbs./ft.<sup>3</sup>. This clay has a minimum shear strength of 640 lbs./ft.<sup>2</sup> at a depth of 30.0'.

cont'd. /4 ...

## 5. GROUND WATER CONDITIONS:

The water table falls gradually from an elevation of 692.6', which is the water level in the adjacent pond, to 688.0', which is that of the creek at the west side of the embankment. In time of flood the water level in the pond rises to 697.0'. The exact water level in each borehole at the time of the investigation may be found in the log sheets.

## 6. DISCUSSION AND RECOMMENDATIONS:

The silty clay with dispersed coarse sand is capable of supporting spread footings with a safe bearing load of 2 T/ft.<sup>2</sup>, at an elevation of 683.5' or lower. As the clay is very dense, 133.0 lbs./ft.<sup>3</sup>, and the liquidity index 0.33; settlement should be within tolerable limits.

As the road elevation is to be raised to 703.6', it is thought that the water level in the pond may be raised to an elevation of 698.0'. The resulting hydraulic head should be dissipated by the time the water has reached the west side of the extended road embankment and a granular toe fill will therefore be unnecessary. Where the road embankment is to be extended on the west side, the soft clay should first be removed to a depth of 5.0' and replaced with suitable fill.

Dewatering will be a problem and the footing excavation must be kept dry. This may be achieved by driving sheet piling approximately one foot into the underlying stiff to very stiff silty clay with dispersed sand (See Drawing 61-F-53A), and using a sump pump.

7. SUMMARY:

7.1) The present road embankment is constructed of a heterogeneous mixture of fine to medium sand, with gravel, silt, and clay. The natural subsoil consists of a layer of soft clay containing some sand and organic matter overlying a very stiff, to stiff, silty clay containing dispersed coarse sand.

7.2) Spread footings with a safe bearing load of 2 T/ft.<sup>2</sup> may be placed at an elevation of 683.5' or lower in the very stiff to stiff silty clay layer indicated in Drawing 61-P-53A.

7.3) The footing excavation must be kept dry and in good condition and this may be done by driving sheet piling approximately 1.0 ft. into the very stiff silty clay and using a sump.

7.4) As the road elevation is to be raised to 703.6', the water level in the pond may be raised to an elevation of 698.0'. It is thought that a granular filter is unnecessary on the west toe of the extended embankment.

8. MISCELLANEOUS:

The drilling operation was carried out by Longyear, Ltd., using a Longyear diamond core drill adapted for soil sampling, using standard wash boring operations. The work was carried out from Thursday, June 8th to Thursday, June 15th, and was supervised by the Department of Highways' Project Engineer, Mr. T. F. Widdis. July 1961.

REPORT PREPARED BY: .....  
T. F. Widdis,  
PROJECT FOUNDATION ENGR.

REPORT APPROVED BY: .....  
A. C. Sternae,  
SUPERVISING FOUNDATION ENGR.



APPENDIX I.

# SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-53

W.P. 213-60

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
1	S1A	3'-4.5'	Clay. Intermediate compressibility. Silty with some fine to coarse sand. Soft.	2	28.4	19.4	44.3	-	-	
	S1B	4.5'-5.0'	Fine to coarse sand. Well graded. With silt and fine gravel. Medium dense. Grey.	8	-	-	-	-	-	
	S2	6'-7.5'	Clay sand and gravel. (Sandy Till). Well graded. Dense. Grey.	42	-	-	-	-	-	
	S3	9'-10.5'	Same as sample 2.	32	-	-	-	-	-	
	S4	14'-15.5'	Clay. With silt and fine to coarse sand, and fine gravel. (Clay Till). Medium dense. Grey.	20						
	S5	20'-21.5'	Clay. Low compressibility. Dispersed coarse sand sized particles. Stiff Grey.	9	16.1	12.2	23.1	-	-	
	S6	26'-27.5'	Same as sample 5.	12	16.2	13.4	22.3	-	-	
	S7	30'-31.5'	Same as sample 5 & 6.	11	16.0	13.4	24.5	-	-	
	S8	35'-36.5'	Same as sample 5.	15	16.3	13.3	24.6	-	-	
	S9	40'-41.5'	Same as sample 6. Intermediate compressibility. Hard.	48	14.0	16.9	32.0	-	-	

# SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-53

W.P. 213-60

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH (L.S.T.)	UNIT WEIGHT (P.C.F.)	REMARKS
2	T1	2'-4'	Clay, with fine sand and organic matter.	Pushed	24.8	-	-	TR=278 V=402	123.0	
	S2	5'-6.5'	Clay. Low compressibility. Silt and some dispersed coarse sand size particles. Very stiff. Grey.	22	15.4	14.4	25.9	-	-	
	S3	10'-11.5'	"	26	13.9	13.4	23.4	-	-	
	S4	14.5'-16'	Same as sample 3.	15	-	-	-	-	-	
	S5	20.7'-22.2'	Same as sample 3.	13	-	-	-	-	-	
	S6	24'-25.5'	Same as sample 3. Stiff.	9	-	-	-	-	-	
	T7	26'-27.5'	Clay. Silt with dispersed coarse sand sized particles. Low compressibility.	Pushed	16.4	13.5	22.0	TR=780 V=966	132.0	
	T8	29'-30.5'	Same as sample 7.	Pushed	17.4	13.3	23.1	TR=631 V=1071	134.0	
	T9	34'-35.5'	Same as sample 8.	Pushed	-	-	-	-	-	
	S10	40'-41.0'	Clay. Intermediate compressibility. With silt and dispersed coarse sand sized particles. Hard. Grey.	36	18.0	16.8	33.3	-	-	

# SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-53

W.P. 213-60

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
3	S1	2'-3.5'	Fine to medium sand and fine gravel. Loose. With silt and clay. 45%.	4	-	-	-	-	-	
	S2	6'-7.5'	Same as sample 1. Some organic matter.	2	-	-	-	-	-	
	S3	10'-10.5'	Fine to medium sand. Loose. Silt and clay.	13	-	-	-	-	-	
		10.5'-11.5'	Clay. Low compressibility. Silt with disperse coarse sand sized particles Hard.	34	-	-	-	-	-	
	S4	15'-16.5'	Same as sample 3.	24	-	-	-	-	-	
	S5	20'-21.5'	Same as sample 3.	24	-	-	-	-	-	
	S6	25'-26.5'	Same as sample 3.	18	-	-	-	-	-	
4	S1	2'-3.5'	Fine to medium sand and fine gravel. Loose. With silt and clay. 45%. Brown.	4	-	-	-	-	-	
	S2	6'-7.5'	Same as above.	2	-	-	-	-	-	
	S3	10'-11.5'	Fine to medium sand. Loose. With silt and clay 20%.	3	-	-	-	-	-	
	S4	15'-16.5'	Clay. Low compressibility. Silt and dispersed coarse sand sized particles. Very stiff.	22	14.8	13.4	24.4	-	-	
	S5	20'-21.5'	Same as sample 4.	25	-	-	-	-	-	

# SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-53

W.P. 213-60

E D.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N	MOIST.	PLASTIC	LIQUID	SHEAR	UNIT	REMARKS
				RESIST. BLOWS/FT.	CONT. %	LIMIT %	LIMIT %	STRENGTH p.s.f.	WEIGHT p.c.f.	
	S1	2'-3.5'	Fine to coarse sand with some clay. Loose. Brown.	4	13.5	-	-	-	-	Blows not representative. Tin Box.
	S2	6'-7.5'	Same as sample 1. (Blows too high).	13	22.8	-	-	-	-	
	S3	10'-11.5'	Silt and clay with fine sand. Soft. Grey.	4	26.7	-	-	-	-	
	S4	15'-16.5'	Clay. Low compressibility. With silt and dispersed coarse sand sized particles. Very stiff.	26	-	-	-	-	-	
6	S1	2'-3.5'	Fine to coarse sand. Medium dense. Brown.	12	-	-	-	-	-	
	S2	6'-7.5'	Clayey silt. Stiff. With some fine sand. Brown.	12	34.0	26.6	44.9	-	-	
	S3	10'-11.5'	Same as sample 2. Medium stiff.	⑥	-	-	-	-	-	
	S4	15'-16.5'	Clay. Low compressibility with silt and some dispersed coarse sand sized particles. Hard.	34	-	-	-	-	-	
	S5	18'-19.5'	Same as sample 4.	27	-	-	-	-	-	
	S1	2'-3.5'	Fine to medium sand. Loose. With some silty clay. Brown.	4	-	-	-	-	-	
	S2	6'-7.5'	Same as sample 1.	5	-	-	-	-	-	

# SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-53

W.P. 213-60

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
7	T3	10'-11.2'	Clay. Low compressibility. Brown.	Pushed	30.7	14.0	26.0	TR=1460	113.8	
					15.2			V=2350		
	S4	15'-16.5'	Clay. Low compressibility. Silt with dispersed coarse sand size particles. Very stiff.	26	-	-	-	-	-	
	S5	17'-18.5'	Same as sample 4.	24	-	-	-	-	-	
			S denotes split spoon sample. T " shelby tube sample. TR " triaxial compression. V " lab. vane.							

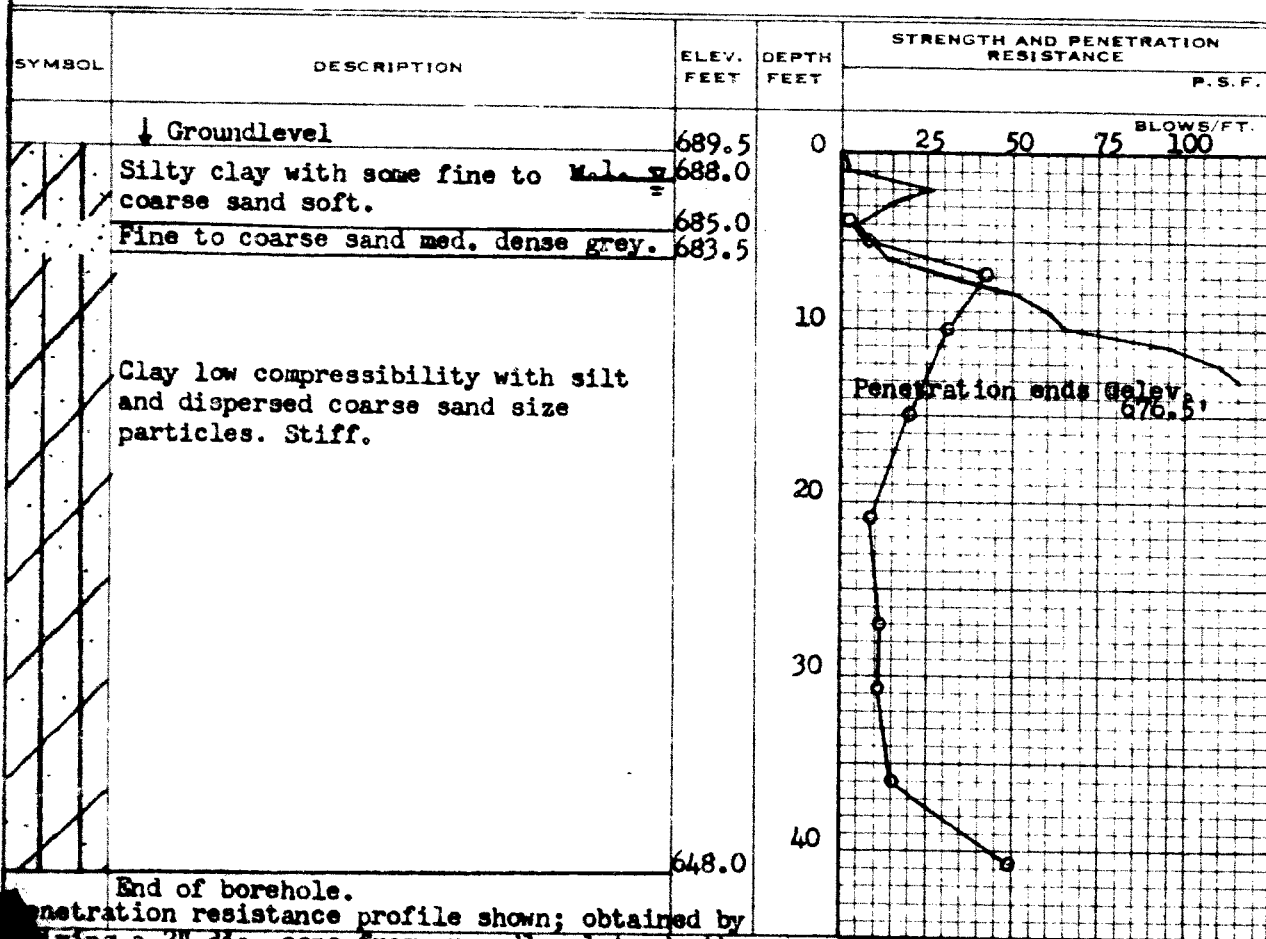
DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS AND RESEARCH SECTION

W.P. 213-60 \_\_\_\_\_ BORE HOLE NO. 1  
JOB 61-F-53 \_\_\_\_\_ STATION 270+04 (33' It.)  
DATUM 689.5' \_\_\_\_\_ COMPILED BY B.K.  
BORING DATE June 8/61. \_\_\_\_\_ CHECKED BY T.F.W.

2" DIA. SPLIT TUBE -----  
2" SHELBY TUBE -----  
2" SPLIT TUBE -----  
2" DIA. CONE -----  
2" SHELBY -----  
CASING -----

## LEGEND

1/2 UNCONFINED COMPRESSION (Qu) -----	○
VANE TEST (C) AND SENSITIVITY (S) -----	+S
NATURAL MOISTURE AND	
LIQUIDITY INDEX -----	X
LIQUID LIMIT -----	
PLASTIC LIMIT -----	



CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.			
10	20	30	
		S1	-
		S2	-
		S3	-
		S4	-
		S5	-
		S6	-
		S7	-
		S8	-
		S9	-
		S10	-

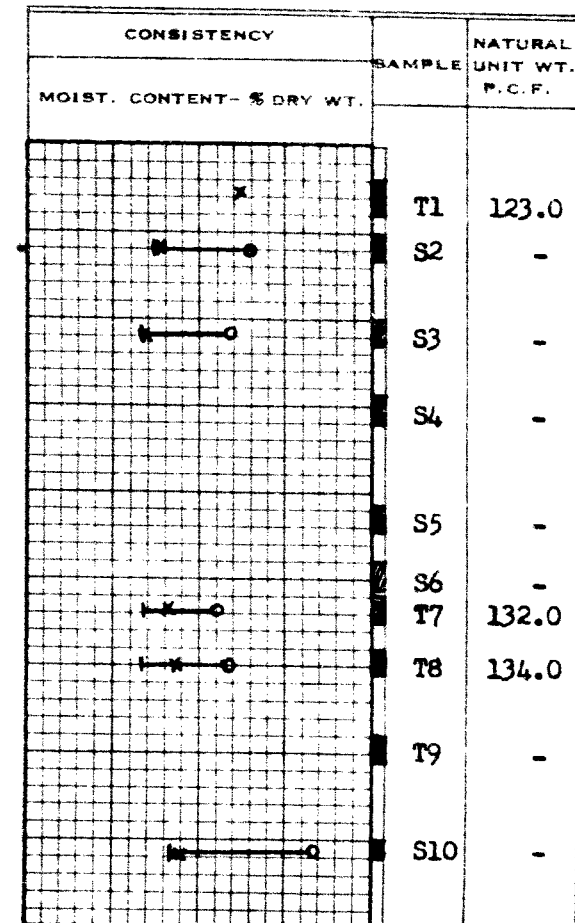
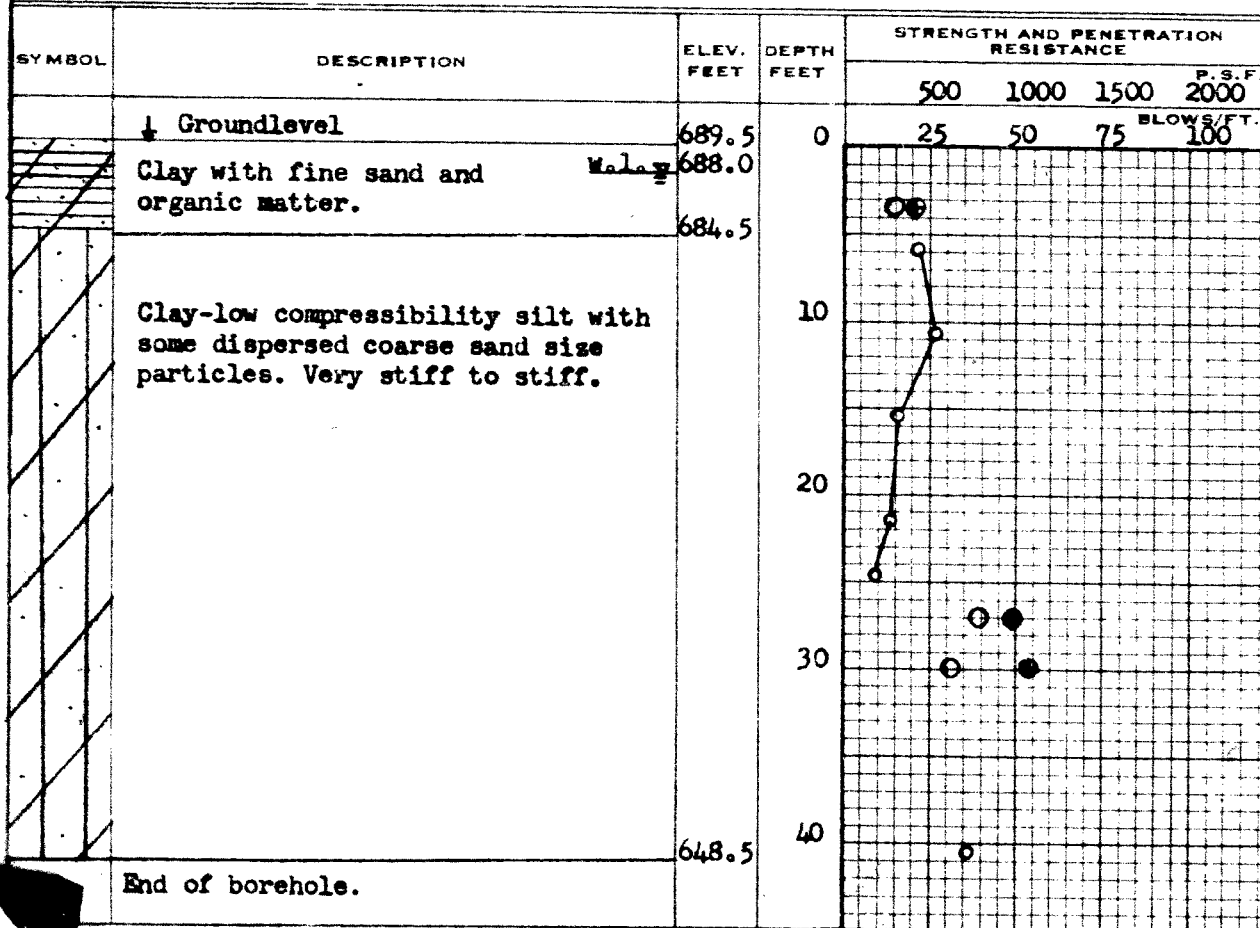
# DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS AND RESEARCH SECTION

W.P. 213-60 BORE HOLE NO. 2  
 JOB 61-F-53 STATION 269+64 (44' L.S.)  
 DATUM 689.5' COMPILED BY B.K.  
 BORING DATE June 12/61. CHECKED BY T.F.W.

2" DIA. SPLIT TUBE  
 2" SHELBY TUBE  
 2" SPLIT TUBE  
 2" DIA. CONE  
 2" SHELBY  
 CASING

## LEGEND

Lab vane - - - - -  
 1/2 UNCONFINED COMPRESSION ( $Q_u$ ) - - -  
 VANE TEST (C) AND SENSITIVITY (S) - - -  
 NATURAL MOISTURE AND LIQUIDITY INDEX - - -  
 LIQUID LIMIT - - -  
 PLASTIC LIMIT - - -





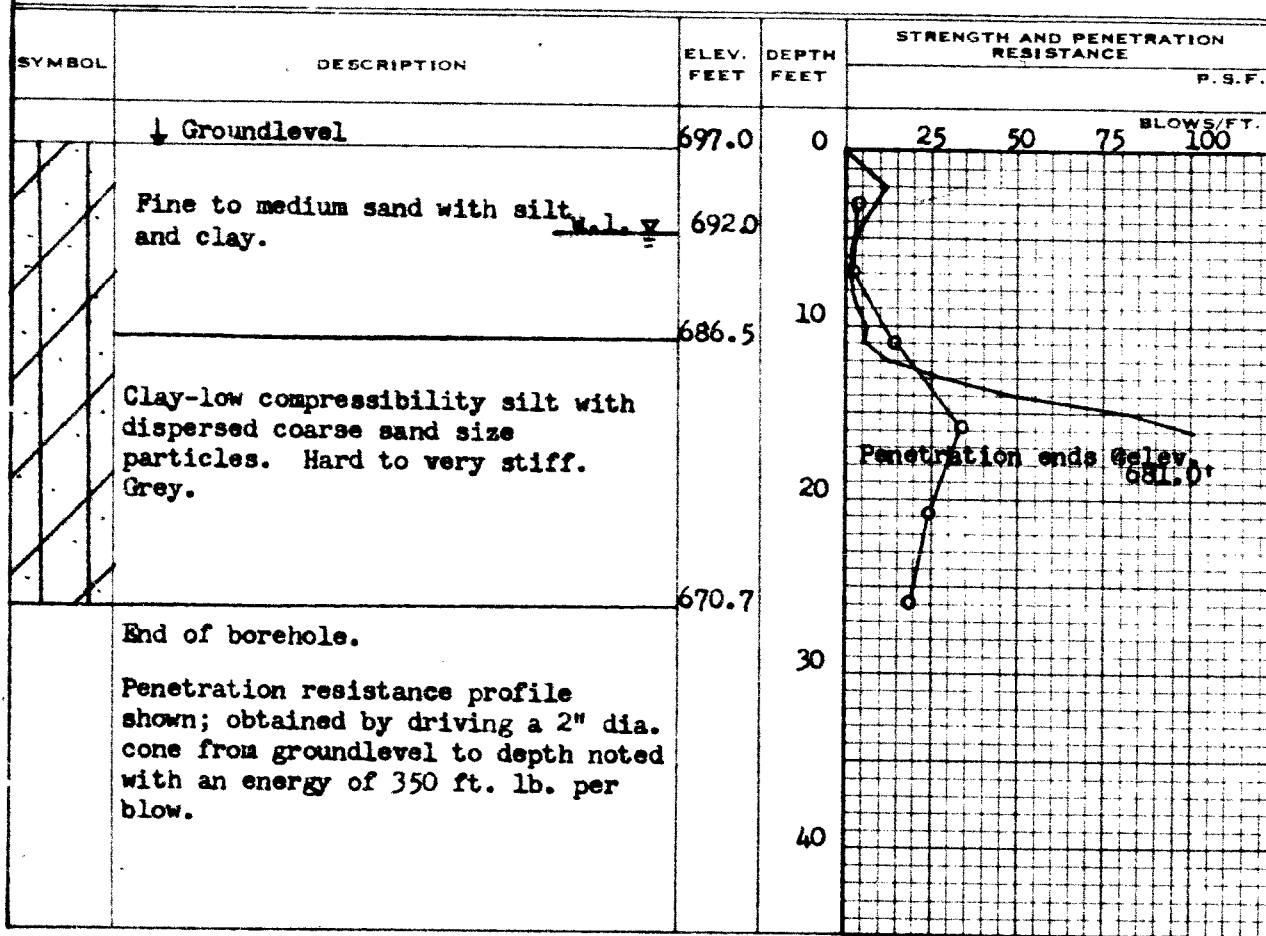
# DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS AND RESEARCH SECTION

W.P. 213-60 BORE HOLE NO. 3  
 JOB 61-F-53 STATION 269+59 (32.0' Rt.)  
 DATUM 697.0' COMPILED BY B.K.  
 BORING DATE June 13/61. CHECKED BY T.F.W.

2" DIA. SPLIT TUBE  
 2" SHELBY TUBE  
 2" SPLIT TUBE  
 2" DIA. CONE  
 2" SHELBY  
 CASING

## LEGEND


1/2 UNCONFINED COMPRESSION ( $Q_u$ )  
 VANE TEST (C) AND SENSITIVITY (S)  
 NATURAL MOISTURE AND LIQUIDITY INDEX  
 LIQUID LIMIT  
 PLASTIC LIMIT



CONSISTENCY	SAMPLE	NATURAL UNIT WT. P. C. F.
MOIST. CONTENT - % DRY WT.		
	S1	-
	S2	-
	S3	-
	S4	-
	S5	-
	S6	-

2" DIA. SPLIT TUBE \_\_\_\_\_  
2" SHELBY TUBE \_\_\_\_\_  
2" SPLIT TUBE \_\_\_\_\_  
2" DIA. CONE \_\_\_\_\_  
2" SHELBY \_\_\_\_\_  
CASING \_\_\_\_\_

1/2 UNCONFINED COMPRESSION (Qu) --- O  
VANE TEST (G) AND SENSITIVITY (S) --- + S  
NATURAL MOISTURE AND LIQUIDITY INDEX --- LI  
LIQUID LIMIT --- X  
PLASTIC LIMIT ---

CONSISTENCY		SAMPLE	NATURAL UNIT WT.
MOIST. CONTENT - % DRY WT.			P.C.F.
0	10      20      30		
		S1	-
		S2	-
		S3	-
		S4	-
		S5	-

# DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS AND RESEARCH SECTION

W.P. 213-60 BORE HOLE NO. 5

JOB 61-F-53 STATION 270+00 (14' Rt.)

DATUM 698.0' COMPILED BY B.K.

BORING DATE June 14/61. CHECKED BY T.F.W.

2" DIA. SPLIT TUBE  
2" SHELBY TUBE  
2" SPLIT TUBE  
2" DIA. CONE  
2" SHELBY  
CASING

## LEGEND

1/2 UNCONFINED COMPRESSION ( $Q_u$ )  
VANE TEST (C) AND SENSITIVITY (S)  
NATURAL MOISTURE AND LIQUIDITY INDEX  
LIQUID LIMIT  
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE	
				P.S.F.	BLOWS/FT.
	↓ Groundlevel	698.0	0		
	Fine to coarse sand with some clay. Loose. Brown.				
	W.L. 691.0	691.0			
		688.0	10		
	Silty clay with some fine sand. Soft. Grey.	683.0			
	Clay with dispersed coarse sand sized particles. Very stiff. Grey.	681.5			
	End of borehole.		20		
			30		
			40		

CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.			
0 10 20 30			
		S1	-
		S2	-
		S3	-
		S4	-

## OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS AND RESEARCH SECTION

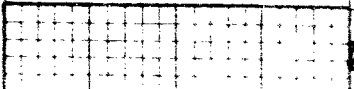
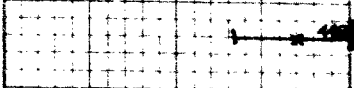
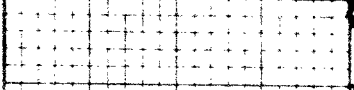
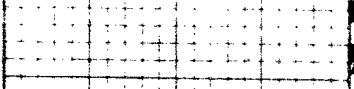

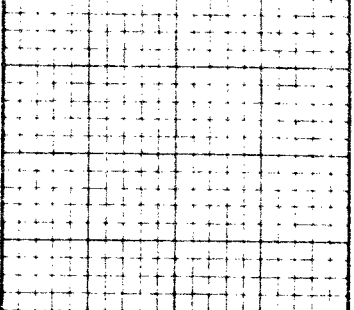
W.P. 213-60 BORE HOLE NO. 6  
JOB 61-F-53 STATION 270+08 (11.0' Lt.)  
DATUM 698.5' COMPILED BY B.K.  
BORING DATE June 15/61. CHECKED BY T.P.W.

2" DIA. SPLIT TUBE  
2" SHELBY TUBE  
2" SPLIT TUBE  
2" DIA. CONE  
2" SHELBY  
CASING

## LEGEND

1/2 UNCONFINED COMPRESSION ( $Q_u$ )  
VANE TEST (C) AND SENSITIVITY (S)  
NATURAL MOISTURE AND LIQUIDITY INDEX  
LIQUID LIMIT  
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE	
				P.S.F.	BLOWS/FT.
	↓ Groundlevel	698.5	0		25 50 75 100
	Fine to coarse sand. Medium dense. Brown.	695.0			
	Clayey silt with some fine sand. Stiff. Brown.	690.5	10		
		684.5			
	Clay with dispersed coarse sand sized particles. Hard to very stiff. Grey.	679.0	20		
	End of borehole.				

CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.			
		S1	-
		S2	-
		S3	-
		S4	-
		S5	-
			

## OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS AND RESEARCH SECTION

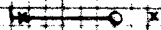
W.P. 213-60 BORE HOLE NO. 7  
 JOB 61-F-53 STATION 269+55 (11.0' It.)  
 DATUM 698.5' COMPILED BY B.K.  
 BORING DATE June 15/61. CHECKED BY T.F.W.

2" DIA. SPLIT TUBE \_\_\_\_\_  
 2" SHELBY TUBE \_\_\_\_\_  
 2" SPLIT TUBE \_\_\_\_\_  
 2" DIA. CONE \_\_\_\_\_  
 2" SHELBY \_\_\_\_\_  
 CASING \_\_\_\_\_

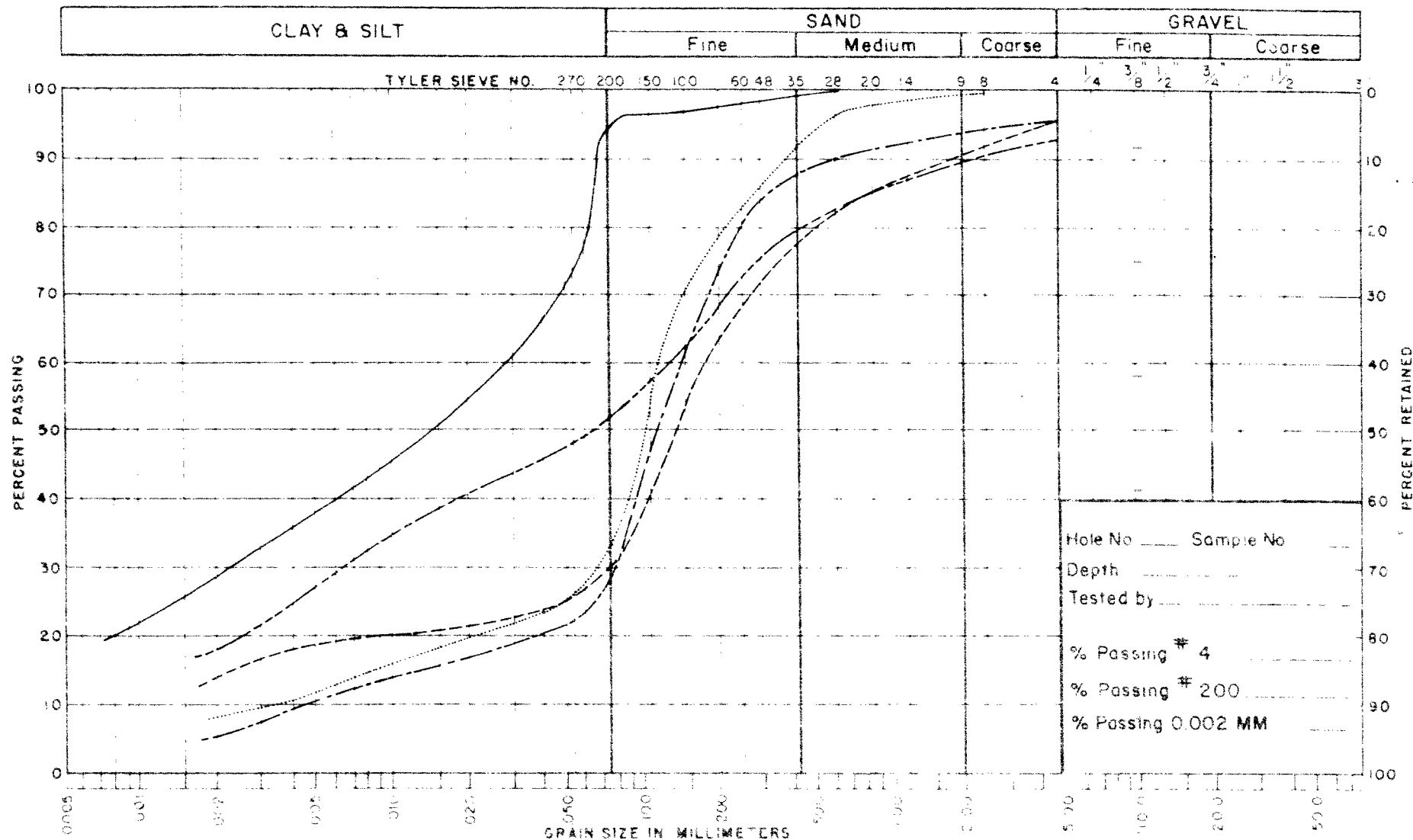
## LEGEND

Lab Vane - - - - - ⊕  
 1/2 UNCONFINED COMPRESSION (Qu) - - - - - ○  
 VANE TEST (C) AND SENSITIVITY (S) - - - - - +  
 NATURAL MOISTURE AND LIQUIDITY INDEX - - - - - LI  
 LIQUID LIMIT - - - - - ○  
 PLASTIC LIMIT - - - - - —

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE	
				P. S. F.	
				BLOWS/FT.	
	↓ Groundlevel	698.5	0	25	50 75 100
	Fine to medium sand with some silt and clay. Loose. Brown.				
		691.0 690.5			
	Clay-low compressibility. Brown.		10		
		683.5			
	Clay with dispersed coarse sand sized particles. Very stiff. Grey.	680.5	20		
	End of borehole.		40		

CONSISTENCY		SAMPLE	NATURAL UNIT WT. P. C. F.
MOIST. CONTENT - % DRY WT.			
		S1	-
		S2	-
		T3	113.8
		S4	-
		S5	-

# UNIFIED SOIL CLASSIFICATION SYSTEM

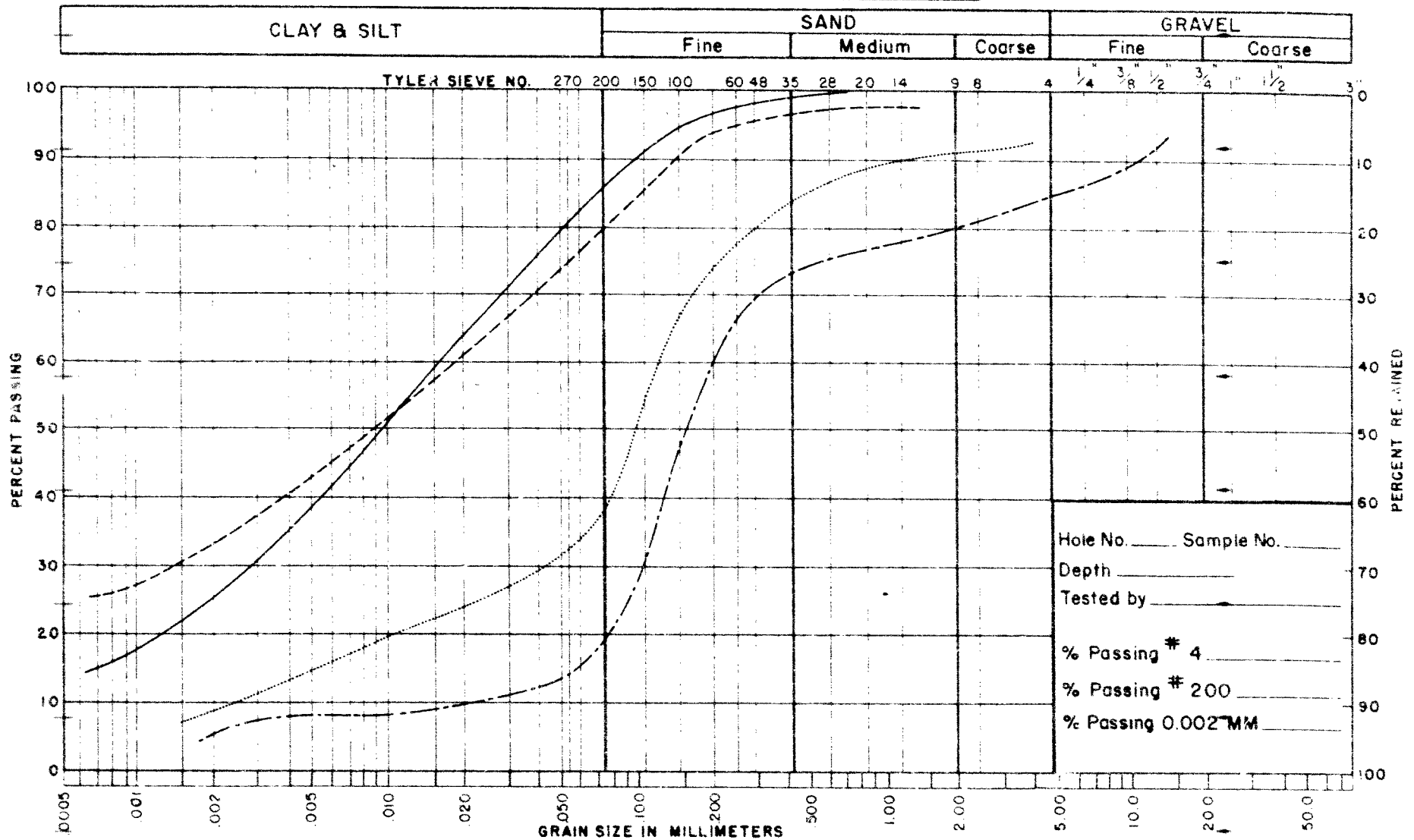


TESTS ————— BORE HOLE NO. 4 SAMPLE 1 ————— " " " " 4 " " 2 ————— " " " " 5 " " 3	B.H. NO. 5 SAMPLE NO. 1 " " " " 5 " " 2 " " " " 5 " " 3
--	---

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH SECTION  
**GRAIN SIZE DISTRIBUTION**

Job No. 61-F-53      Date No. 215-60  
 Location HWY. NO. 21 CODERICH

# UNIFIED SOIL CLASSIFICATION SYSTEM



NOTES	BORE HOLE NO.	SAMPLE NO.
-----	6	2
-----	6	3
-----	7	1

## DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS & RESEARCH SECTION GRAIN SIZE DISTRIBUTION

Job No. 61-P-53 W.P. No. 213-60  
Location HWY. NO. 21 GODERICH

Mr. J. Roy,  
Regional Materials Engr.,  
London Regional Office.

Attn: Mr. J. Forster

Mr. A. G. Stermac  
Principal Foundation Engineer,  
Foundation Section,  
Materials & Research Division.  
November 6, 1963

W.P. 213-60 - W.J. 61-F-53  
Hwy. #21, Goderich Northerly,  
District #3

In our memo of August 6, 1963, to Mr. S. McCombie, Bridge Planning Engineer, we commented on the various proposed dam elevations. In conclusion, we pointed out that very little information on the embankment and the underlying soil was available, and therefore, more conclusive comments and recommendations were not possible. We also pointed out the fact that the existing embankment was not originally built as a water retaining structure and that therefore, the materials used may not be best suited for the presently proposed purpose.

We are now in receipt of the results of additional borings carried out by the Regional Material Engineer's personnel. These results are summarized on the attached drawing (61-F-53B) on which two cross- and two longitudinal sections are shown. The soil stratification is drawn on these sections.

It is evident from this drawing that a number of different materials were used for the embankment construction and also, that in places, the soft organic topsoil was not removed prior to embankment construction. Some of the embankment materials are rather permeable due to their sandy character. It appears that these materials are presently above the prevailing pond water table.

On the basis of the results of the most recent investigation, it can now be concluded that it would be advisable to have the pond level raised as little as possible.

If the desired dam level raise of 4.0 ft. is carried out, the water during flood, may be anticipated to rise to elev. 700.00. With a 3.6 ft. high freeboard, the embankment would have to be raised up to elev. 703.60 which is about 5 to 5.5 ft. above the present elevation. We are unable to state specifically that a failure will occur in this case; however, in the light of the available data we can say that difficulties are very probable.

AGS/MdeP

Attach.

cc: Messrs. S. McCombie  
W. McFarlane

Foundations office  
Gen. Files ✓

A. G. Stermac  
PRINCIPAL FOUNDATION ENGINEER